

REMARKS

Applicant concurrently files herewith a excess claim fee payment letter for ten (10) additional claims.

Claims 1-32 are all the claims presently pending in the application. Claims 1-22 stand rejected on prior art grounds. Claims 23-32 are added to claim addition features of the invention. This Amendment amends claims 1, 14, 18, 20, and 22. Attached hereto is a marked-up version of the changes made to claims by the current Amendment.

It is noted that the claim amendments are made to merely clarify the language of each claim, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. It is further noted that, notwithstanding any claim amendments made herein, Applicant's intent is to encompass equivalents of all claim elements, even if amended herein or later during prosecution.

Regarding the prior art rejection, claims 1-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable by Sung (U.S. Pat. No. 6,184,945) in view of Yamazaki et al (Yamazaki) (U.S. Pat. No. 6,118,506).

This rejection is respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention is directed to a liquid-crystal display device that includes a plurality of address wires formed on an insulating substrate, a gate insulating film formed on the address wires and on the insulating substrate, a plurality of data wires, the data wires crossing the address wires, an upper layer insulating film formed on the data wires and on the gate insulating film, the upper layer insulating film having a smaller thickness than the gate

insulating film.

The invention also includes a picture element area comprising a transparent electrode, comprising a transparent conductive film, formed on the upper layer insulating film and surrounded by address wires and data wires, and a thin-film transistor section for selectively connecting the data wires with transparent electrode by a gate connected to the address wires. The invention further includes a capacitor section comprising a first electrode formed on the gate insulating film and comprising the same conductive film as in the data wires, a second electrode on the upper layer insulating film and comprising the same transparent conductive film as in the transparent electrode, and at least a portion of the upper layer insulating film formed between the first electrode and the second electrode.

Conventional liquid crystal display devices form a capacitor section using an auxiliary capacitive common electrode, a gate insulating film, and a storage electrode. However, in such a case the thickness of the dielectric layer and dielectric constant are limited, and the area of the electrode is increased if electrostatic capacity must be increased. As a result, the display is poorly lit and power consumption is increased.

The claimed device, on the other hand, includes a capacitor section including a first electrode formed on the gate insulating film and including the same conductive film as in the data wiring, and a second electrode formed on the upper layer insulating film and including the same transparent conductive film as in the transparent electrode. At least a portion of the upper layer insulating film is formed between the first electrode and the second electrode. Importantly, the upper layer insulating film has a thickness which is smaller than the thickness of the gate insulating film.

As result, the capacitor section has larger electrostatic capacitance per area compared

with the case of the conventional liquid-crystal device using the gate insulating film as a dielectric layer in the capacitor section, which improves the aperture ratio.

II. THE PRIOR ART REFERENCES

The Examiner alleges that Sung in view of Yamazaki teaches the claimed invention. Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested the Examiner's urged combination of references.

THE SUNG AND YAMAZAKI REFERENCES

Sung discloses a liquid crystal display apparatus that includes electrodes which are opposed to pixel electrodes and which generate cumulative capacitance. Gate electrodes and the substrate are covered with a first (gate) insulating film. Over the first insulating film is a semiconductor active film. A second insulating film corresponds to a pixel part and is provided to cover the thin film transistors, the first insulating film, and source wires.

The Examiner admits that Sung does not teach varying the thickness and dielectric material of the two insulating layers in order to control the respective capacitances.

As a result, the Examiner relies on Yamazaki for allegedly teaching that a dielectric film with a minimum dielectric constant and large thickness is used as an insulating film between the gate and auxiliary capacitance electrode in order to minimize parasitic capacitance. Further, the Examiner alleges that Yamazaki teaches that a dielectric film having a maximum relative dielectric constant and small thickness is used as insulating film between the auxiliary capacitance electrode and pixel electrode in order to create retaining capacitors having desired capacitance.

Applicant respectfully disagrees.

Yamazaki discloses creating retaining capacitors in a liquid crystal display in every region where a black matrix 316 overlaps pixel electrodes 318. Parasitic capacitances created between the black matrix 316 and the gate and data lines can be reduced to a negligible level (Yamazaki, col. 7, lines 21-50).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different objectives and matters than those of the present invention.

Specifically, Sung discloses a film insulating layer that is sandwiched between a first electrode film and a pixel electrode to form cumulative capacity that cancels out part of the parasitic capacity created in the liquid crystal display apparatus (Sung, col. 9, lines 43-55). On the other hand, Yamazaki discloses forming new capacitors in regions where a black matrix overlaps pixel (e.g. transparent) electrodes. Yamazaki discloses a dielectric film having a minimum relative dielectric constant for use as a second interlayer dielectric film having a large thickness and uses a third interlayer dielectric film having a maximum relative dielectric constant and a small thickness to create a structure to act as a retaining capacitor (col. 7, lines 38-48).

Therefore, the object of Yamazaki is to form a structure to act as a retaining capacitor using the black matrix and pixel electrodes with multiple underlying dielectric layers (col. 2, lines 57-60), while Sung provides greater cumulative capacity by using a single insulating film, which acts as a dielectric layer, that is sandwiched between an electrode film and pixel electrodes (Sung, col. 3, lines 2-12). Further, Sung does not utilize a black matrix filter or varying thicknesses of the underlying dielectric layers to enhance retaining capacitance.

Adding a black matrix filter to Sung to create additional capacitance would add an additional electrode-like structure to Sung's device, which is contrary to Sung's specific disclosure of using two electrodes (see Sung, electrode film 103 and pixel electrode 88a in Fig. 5).

In fact, Sung teaches against using varying thicknesses and additional interlayer dielectric films to create a retaining capacitor:

With the above structure, the cumulative capacity is formed not by a plurality of insulating films as is the case with conventional structures but by a single insulating film. This means that the inventive structure using a single film may have a reduced facing electrode area to provide the same cumulative capacity as that of the conventional structure utilizing a plurality of insulating films (Sung., col. 2, lines 59-67) (emphasis Applicant's).

Given these disparate objects, problems allegedly solved, and unusual solutions, the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged. The prior art references themselves must suggest the desirability, and thus the obviousness, of making the combination, independent of the present invention and a thorough reading of Applicant's own specification. Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. Certainly no person of ordinary skill in the art would consider combining such divergent devices, absent hindsight.

Thus, Applicant respectfully submits that these references would not have been combined as alleged by the Examiner. Further, even if combined, the combination would not teach or suggest the claimed invention.

The deficiencies of Sung are described above. Contrary to the Examiner's allegations, Yamazaki fails to make up for these deficiencies. The Examiner has alleged that column 7, lines 21-55 of Yamazaki teaches the formation of retained capacitances in the regions where

the black matrix filter overlaps the pixel electrodes, using a thick second interlayer dielectric film, thin third interlayer dielectric film structure and “varying the thickness and dielectric material of the two insulating layers in order to control the respective capacitances,” (Office Action, p. 2). However, neither Sung nor Yamazaki teach “a gate insulating film formed on said address wires and on said insulating substrate,” and “an upper layer insulating film formed on said data wires and on said gate insulating film,” said upper layer insulating film having a smaller thickness and higher dielectric constant than the gate insulating film,” as recited in claim 1, nor do the references teach or suggest “forming a first electrode using the same conductive film as used to form said data wiring; forming an upper layer insulating film on said first electrode and on said gate insulating film,” said upper layer insulating film having a smaller thickness than the gate insulating film; forming a second electrode using the same transparent conductive film as used to form said transparent electrode,” as recited in claim 22 (emphasis Applicant’s) (remarks herein regarding claim 1 are hereby incorporated into remarks regarding independent method claim 22).

The claimed Application, and the Examiner’s description, specifically recite “the two insulating layers,” (e.g. a gate insulating film 5 and an upper insulating film 8) (Application, Fig. 2; Office Action, p. 2).

In the claimed invention, the upper insulating film is formed either on the gate insulating film or the two layers are separated by data wiring electrodes. In the preferred embodiment, transparent (e.g. pixel) electrode 6/25 is formed on the upper insulating film 8 (Application, Fig. 2). As stated above, the claimed invention recites “said upper layer insulating film having a smaller thickness and higher dielectric constant than the gate insulating film,” in claim 1. This is specific structure utilizing the larger thickness of the gate

insulating film and the smaller thickness of the upper insulating film to increase cumulative capacitance of the liquid display device (e.g. across the TFT section 103, image section 104, and capacitor section 105). In an exemplary embodiment, electrostatic capacitance is preferably accumulated between the first electrode 10 and transparent electrode 25 (extending from transparent electrode 6) (Application, p. 24, lines 14-18).

In contrast, the structure disclosed by Yamazaki does not teach varying the thicknesses of the “two insulating layers” to increase capacitance. Yamazaki appears to form a retaining capacitor with a black matrix filter 316, overlying pixel electrodes 318 and a third interlayer dielectric insulating film 317 (col. 3, lines 12-15), which is a different structure than the present invention. Yamazaki has two separate, additional insulating layers (e.g. anodic oxide layer 306 and first interlayer dielectric film 313) between gate electrode 307 and adds black matrix filter 316. The layer actually used by Yamazaki to create the capacitance is not the gate insulating layer, as claimed by the present invention.

Thus, Yamazaki does not teach or suggest “a gate insulating film formed on said address wires and on said insulating substrate,” and “an upper layer insulating film formed on said data wires and on said gate insulating film,” as recited in claim 1.

The present invention claims two insulating layers: a gate insulation film 5 and upper insulation film 8 (claim 1, Fig. 2). In contrast, Yamazaki teaches four insulation layers, including gate-insulation film layer 303 (col. 4, line 61), a first interlayer dielectric film 313 (col. 6, line 14), a second interlayer dielectric film 315 (col. 6, line 24), and a third interlayer dielectric film 317 (col. 6, lines 48-49). The first and second interlayer dielectric films are formed between gate insulating film 303 and the third interlayer dielectric film 317, whereas, in the claimed invention, upper insulating film 8 is formed on gate insulating film 5 (and any

intervening electrodes such as data wiring 10) (Application, Fig. 2). In Yamazaki, gate insulating film 303 is not used to create the capacitor 319, whereas gate insulating film 5 is an integral part of the claimed invention.

In addition to including the first interlayer dielectric film, Yamazaki also teaches that forming the second interlayer dielectric film is a requirement to create the structure of Yamazaki (col. 7, line 41). However, neither Yamazaki's first nor second interlayer dielectric films are part of the gate insulating film layer 303. Therefore, Yamazaki teaches that additional dielectric film layers (and processing steps) are required to complete the capacitance structure but does not teach or suggest "a gate insulating film formed on said address wires and on said insulating substrate" and "an upper layer insulating film formed on said data wires and on said gate insulating film," as recited in claim 1.

Further, the present invention claims that "said upper layer insulating film having a smaller thickness and higher dielectric constant than the gate insulating film," as recited in claim 1. Yamazaki's "gate-insulating film layer" 303 has a thickness of 1200 Angstroms (0.12 μm) (col. 4, line 60) and the third (e.g. upper) interlayer dielectric film 317 is 0.1 to 0.3 μm (col. 6, line 49). These films are essentially the same thicknesses and clearly Yamazaki does not teach that the third interlayer dielectric film has a smaller thickness than the gate insulating film. Therefore, there is no teaching or suggestion in Yamazaki of "said upper layer insulating film having a smaller thickness and higher dielectric constant than the gate insulating film." Clearly, Sung and Yamazaki do not teach these novel features.

The Examiner has further alleged that column 7, lines 21-55 of Yamazaki teaches that a dielectric film having a maximum relative dielectric constant and small thickness is used as insulating film between the auxiliary capacitance electrode and pixel electrode in order to

create retaining capacitors. Yamazaki actually uses black matrix filter 316 where it overlaps pixel electrodes 318 to create a capacitance. However, a black matrix is clearly not an electrode.

“A black matrix screen is a attempt to overcome the loss in luminance and resultant brightness due to the use of a neutral density filter as the faceplate to increase the contrast ratio.”¹ A black mask can be deposited in the optically inactive areas to prevent light leakage and, in many cases, provide a light shield for the amorphous silicon transistors.² While a black matrix material can be organic or inorganic, with chromium a popular inorganic choice,³ a black matrix filter is not defined as an “auxiliary capacitance electrode.” Yamazaki may disclose a way of using a black matrix filter to replace traditional capacitance lines, but this is a different structure and different technology than a capacitor section comprising: a first electrode formed on said gate insulating film and comprising the same conductive film as in said data wires” and “a second electrode on said upper layer insulating film and comprising the same transparent conductive film as in said transparent electrode,” as recited in claim 1.

The present invention discloses the use of a black matrix filter in the liquid-crystal display for its intended purpose. In an exemplary embodiment, “the whole capacitor section is substantially housed in the black matrix” which maximizes the aperture ratio (Application, p. 39). Adding a black matrix filter to the claimed invention to create additional capacitance would add a third structure to the claimed “first electrode formed on said gate insulating film

¹Joseph A. Castellano, Handbook of Display Technology, Academic Press, Inc., San Diego, Ca. (1992), p. 43 (copy attached hereto for the Examiner’s convenience).

² Id., p. 299 (copy attached hereto for the Examiner’s convenience).

³Id.

and comprising the same conductive film as in said data wires” and “second electrode on said upper layer insulating film and comprising the same transparent conductive film as in said transparent electrode,” as recited in claim 1. A black matrix is clearly not part of the structure of the claimed invention.

Further, Yamazaki’s black matrix structure is not even formed on the gate insulating film layer 303. In an exemplary embodiment, the capacitor section preferably comprises transparent (e.g. pixel) electrode 25 and data wiring electrode 10 sandwiching the upper insulating film 8 and further includes gate insulating film 5 sandwiched between the data wiring electrode 10 and address electrode wiring 11 (Application, Fig. 2).

Therefore, the claimed invention recites data and address electrodes using two dielectric insulating layers, where the upper insulating layer has a smaller thickness and higher dielectric constant than the gate insulating layer, to create a capacitor section for increasing cumulative capacity in forming a liquid crystal display. On the other hand, Yamazaki discloses four insulation layers in forming a capacitance section (Yamazaki, Fig. 4B), where the third insulating layer 317 is not formed on the gate insulating layer, and only one electrode 318.

Hence, Yamazaki does not teach or suggest “a capacitor section comprising: a first electrode formed on said gate insulating film and comprising the same conductive film as in said data wires; a second electrode on said upper layer insulating film and comprising the same transparent conductive film as in said transparent electrode; and at least a portion of said upper layer insulating film formed between said first electrode and said second electrode . . . wherein said capacitor section is superimposed on said address wires through said gate insulating film,” as recited in claim 1.

Thus, turning to the exemplary language of claim 1, there is no teaching or suggestion of “a plurality of address wires formed on an insulating substrate; a gate insulating film formed on said address wires and on said insulating substrate; a plurality of data wires, said data wires crossing said address wires; an upper layer insulating film formed on said data wires and on said gate insulating film, said upper layer insulating film having a smaller thickness and higher dielectric constant than the gate insulating film; a picture element area comprising: a transparent electrode, comprising a transparent conductive film, formed on said upper layer insulating film and surrounded by said address wires and said data wires; a thin-film transistor section for selectively connecting said data wires with said transparent electrode by a gate connected to said address wires; and a capacitor section comprising: a first electrode formed on said gate insulating film and comprising the same conductive film as in said data wires; a second electrode on said upper layer insulating film and comprising the same transparent conductive film as in said transparent electrode; and at least a portion of said upper layer insulating film formed between said first electrode and said second electrode,” as defined by independent claim 1 (emphasis Applicant’s).

Further, turning to the exemplary language of claim 22, there is no teaching or suggestion of “forming a plurality of address wiring on an insulating substrate; forming a gate insulating film on said address wiring and on said insulating substrate; forming a plurality of data wiring on said gate insulating film, so that said data wiring and said address wiring cross each other; forming a thin-film transistor for selectively connecting said data wiring with a transparent electrode by a gate connected to said address wiring, said transparent electrode being located in a picture element area surrounded by said address wiring and data wiring;

*forming a first electrode using the same conductive film as used to form said data wiring;
forming an upper layer insulating film on said first electrode and on said gate insulating film,
said upper layer insulating film having a smaller thickness than the gate insulating film;
forming a second electrode using the same transparent conductive film as used to form said
transparent electrode; and forming a capacitor section using said first electrode, said second
electrode, and said upper layer insulating film," (emphasis Applicant's).*

For at least the reasons outlines above, Applicant respectfully submits that Sung and Yamazaki fail to teach or suggest each and every feature of claims 1 and 22. Accordingly, Sung and Yamazaki fail to render obvious claims 2-21, depending from claim 1.

Therefore, the Examiner is respectfully requested to withdraw the rejection.

III. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1-32, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

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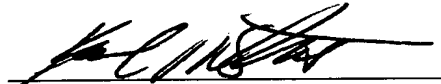
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The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE
IN THE CLAIMS:

The claims were amended as follows:

1. (Three Times Amended) A liquid-crystal display device comprising:
a plurality of address wires formed on an insulating substrate;
a gate insulating film formed on said address wires and on said insulating substrate;
a plurality of data wires, said data wires crossing said address wires;
an upper layer insulating film formed on said data wires and on said gate insulating film, said upper layer insulating film having a smaller thickness than the gate insulating film;
[and]
a picture element area comprising:
a transparent electrode, comprising a transparent conductive film, formed on said upper layer insulating film and surrounded by said address wires and said data wires;
a thin-film transistor section for selectively connecting said data wires with said transparent electrode by a gate connected to said address wires; and
a capacitor section comprising:
a first electrode formed on said gate insulating film and comprising the same conductive film as in said data wires;
a second electrode on said upper layer insulating film and comprising the same transparent conductive film as in said transparent electrode; and
at least a portion of said upper layer insulating film formed between said first electrode and said second electrode.
14. (Three Times Amended) A method for producing the liquid-crystal display device of claim 1, comprising:
forming a plurality of address wiring on an insulating substrate;
forming a gate insulating film on said address wiring and on said insulating substrate;

forming a plurality of data wiring on said gate insulating film, so that said data wiring and said address wiring cross each other;

forming a thin-film transistor for selectively connecting said data wiring with said transparent electrode disposed in each picture element area by a gate connected to said address wiring, in each picture element area surrounded by said address wiring and data wiring;

forming a first electrode using the same conductive film as used to form said data wiring;

forming an upper layer insulating film on said first electrode and on said gate insulating film, said upper layer insulating film having a smaller thickness than the gate insulating film;

forming a second electrode using the same transparent conductive film as used to form said transparent electrode; and

forming said capacitor section using said first electrode, said second electrode, and said upper layer insulating film.

18. (Three Times Amended) A method for producing the liquid-crystal display device of claim 11, comprising:

forming a plurality of address wiring on an insulating substrate;

forming a plurality of auxiliary capacitive common wiring parallel with said address wiring;

forming a gate insulating film on said auxiliary capacitive common wiring and on said insulating substrate;

forming a plurality of data wiring on said gate insulating film, so that said address wiring and data wiring cross each other;

forming a thin-film transistor for selectively connecting said data wiring with said transparent electrode in each picture element area by a gate connected to said address wiring, in each picture element area surrounded by said address wiring and data wiring;

forming said first electrode using the same conductive film as used to form said data wiring;

forming said upper insulating film on said first electrode and on said gate insulating film, said upper layer insulating film having a smaller thickness than the gate insulating film;

forming said second electrode using the same transparent conductive film as used to form said transparent electrode; and

forming said capacitor section using said first electrode, said second electrode and said upper layer insulating film so that said capacitor is one of partially and totally superimposed on said auxiliary capacitive common wiring.

20. (Three Times Amended) A method for producing the liquid-crystal display device of claim 4, comprising:

forming a plurality of address wiring on an insulating substrate;

forming a gate insulating film on said address wiring and on said insulating substrate;

forming, in said gate insulating film, a through hole which extends to said address wiring;

forming a plurality of data wiring on said gate insulating film so that said address wiring and data wiring cross each other;

forming a thin-film transistor for selectively connecting said data wiring with said transparent electrode in each picture element area by a gate connected to said address wiring, in each picture element area surrounded by said address wiring and data wiring;

forming said first electrode using the same conductive film used to form said data wiring;

connecting said first electrode to said address wiring via said through hole formed in said gate insulating film;

forming said upper layer insulating film on said first electrode and on said gate insulating film, said upper layer insulating film having a smaller thickness than the gate insulating film;

forming said second electrode using the same transparent conductive film used to form said transparent electrode; and

forming said capacitor section using said first electrode, said second electrode and said upper layer insulating film.